

THE LLANDOVERY ENTELETACEAN BRACHIOPODS OF THE CENTRAL OSLO REGION, NORWAY

by B. GUDVEIG BAARLI

ABSTRACT. Details of the precise change in brachiopod faunas from the Ordovician to the Silurian systems are elusive. A rich shelly fauna spans the Ordovician/Silurian boundary in the Oslo Region. The brachiopods are the most prominent group represented in the lower Silurian Solvik Formation and among these the enteletaceans are most abundant. Several of these earliest occurring enteletaceans show a Bohemian affinity. Many of the genera described mark their first or last world-wide occurrence in this region. One genus and nine new species are described out of a total of twenty enteletacean species; the remainder are reviewed and redescribed as necessary. The new genus is *Kampella* and the new species are: *Resserella matutina*, *Mendacella bleikeriensis*, *Marklandella markesi*, *Kampella guttula*, ?*Paurorthlis inopinatus*, ?*Diorthelasma semotum*, *Salopina pumila*, *Chrustenopora askeriensis*, and *Jezercia rongi*. One family, the Chrustenoporidae, is elevated from subfamily rank and transferred from the Orthacea to the Enteletacea.

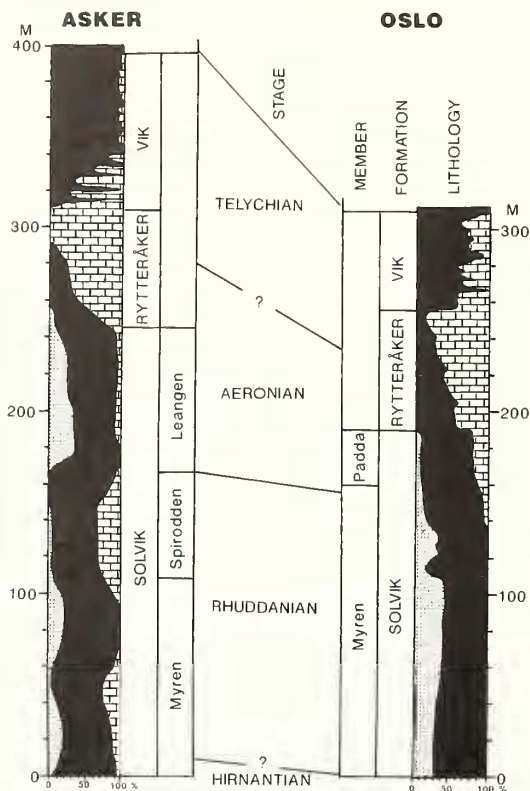
TAXONOMIC treatment of Llandovery (Lower Silurian) faunas in the Oslo Region was first undertaken by the author as a basis for local palaeoecological studies. Subsequently, it became clear that these faunas shed light on the timing and character of Late Ordovician extinctions and the ensuing response by the surviving Silurian fauna. The work also gave more precise ranges for many genera. The largest group, the Enteletacea, with twenty out of about 110 brachiopod species, is treated in this paper. A detailed description is given of nine new species. The remainder have been reviewed and new information added where available. The material described is housed in the type and auxiliary collections of the Paleontologisk Museum, University of Oslo.

Previous taxonomic work in the Llandovery of the Oslo Region is sparse. Thomsen and Baarli (1982) and Cocks and Baarli (1982) gave an overview of earlier work and a preliminary list of species found in the Llandovery of the central Oslo Region. The only enteletacean described from local sequences before 1982 is *Dicoelosia osloensis* Wright, 1968a.

More general work on the Llandovery faunas of the Oslo and Asker districts includes Baarli (1987), which provides a palaeoecological treatment of associations from the systemic boundary up to mid-Aeronian strata. Baarli and Harper (1986) reviewed the Rhuddanian fauna in consideration of the extinction event near the systemic boundary. Also of interest are studies of the uppermost Ordovician fauna of the Oslo-Asker districts, which were treated both ecologically (Brenchley and Cocks 1982) and taxonomically (Cocks 1982). There are, however, very few taxa in common between the Upper Ordovician and Lower Silurian.

STRATIGRAPHY AND SAMPLING

The lithostratigraphy, biostratigraphy, and sedimentology of the Llandovery Series in the Oslo Region has been described by Worsley *et al.* (1983), Baarli (1985), and Baarli and Johnson (in press). The sediments were mixed siliciclastic and carbonates in the lowermost Solvik Formation, carbonates in the overlying Rytteråker Formation, and shales with minor carbonate nodules in the uppermost Vik Formation (text-fig. 1). The age of the sequence is also shown in text-fig. 1. The Myren and Spirodden members of the Solvik Formation in the Asker District and most of the Myren Member of the Solvik Formation in the Oslo District are Rhuddanian of age. The rest of the Solvik Formation and parts of the Rytteråker Formation in both



TEXT-FIG. 1. Stratigraphic sections from the Asker and Oslo districts showing variation in silt/sandstone, shale, and limestone contents per metre section, lithostratigraphic and chronostratigraphic correlation.

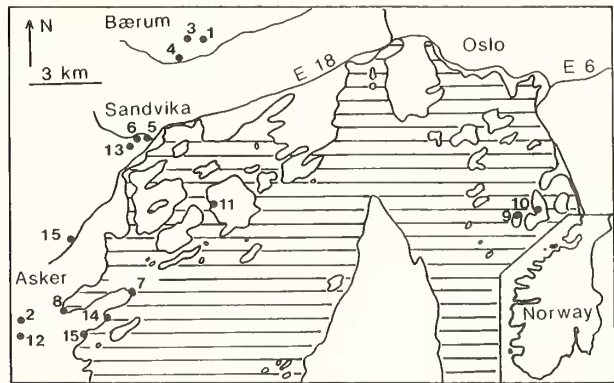
the Asker and the Oslo districts are Aeronian in age (text-fig. 1). Upper parts of the Rytteråker Formation and the Vik Formation are Telychian in age.

Most of the fossil material was retrieved from bulk samples collected at 5 m intervals through the lower Solvik Formation in the central Oslo Region. This material was treated with hydrochloric acid and yielded good moulds. The other formations were spot-sampled. The Rytteråker Formation is much poorer in enteleleaceans. Those present are under-represented due to the difficulty of retrieval from very hard, metamorphosed limestone. Although collecting is easier in the Vik Formation, they are not common in that unit either. The very base of the Vik Formation is an exception, where several thin shale horizons contain extremely rich faunas from mixed communities. All sampled localities mentioned in the text are indicated on text-fig. 2.

PALAEOECOLOGY OF THE ENTELELEACEANS

An analysis of seven faunal associations from the Ordovician/Silurian boundary layers to mid-Aeronian strata (Baarli 1987) showed that enteleleacean brachiopods were not an ecologically homogenous group. One of the most common species, *Isorthis prima*, occurs in all associations present in the Oslo-Asker districts throughout its long range, from layers at the boundary to a mid-Aeronian position. It was the dominant taxon in two associations, and common in all the others except one. In terms of the classical Silurian communities described by Ziegler *et al.* (1968), this enteleleacean was found in the *Clorinda* through *Stricklandia* communities and also the *Cryptothyrella* community. Thus it must have been very eurytopic. Another common element occurring in several associations was *Dicoelosia osloensis*. This species, however, showed very clear preferences for the *Clorinda* related associations with rare membership in the *Stricklandia* related associations. *Mendacella bleikeriensis* is common in the *Cryptothyrella* community, but sometimes

TEXT-FIG. 2. Map of the central Oslo Region with sampled sections marked. 1, Avløs; 2, Bleikerveien; 3, Chr. Skredsvik vei; 4, Gjettem; 5, Jongsåsveien; 6, Kampebråten; 7, Konglungo; 8, Leangbukta; 9, Malmøykalven; 10, Malmøya; 11, Ostoya; 12, Skytterveien; 13, Solhaugveien; 14, Spirodden; and 15, Vettre Brygge.



occurs in most of the other associations. *?Diorthelasma semotum* appears rarely in three different associations, from a *Dicoelosia* through a *Stricklandia* to a *Cryptothyrella* related association. Other locally common enteletaceans (e.g. *Dalmanella* cf. *pectinoides*, *Marklandella markesi* sp. nov., and *Resserella matutina* sp. nov.) seem to be restricted separately to different communities, and hence are considered stenotopic.

The enteletaceans found near the systemic boundary will be treated in detail below. They are minor components of their associations, however, and most disappear gradually through the first 40 m of the section, without a change in the dominant associated taxa or accompanying lithological changes.

THE FAUNA AT THE ORDOVICIAN—SILURIAN BOUNDARY

The fauna spanning the boundary beds between the Ordovician and Silurian systems is not as well known as that in the immediately underlying or overlying beds. This is due mostly to the worldwide eustatic fall in sea-level at the end of the Ordovician and the following rapid rise in sea-level which continued into the earliest Silurian. In many places, this sea-level change caused an unconformity above shallow epicontinental strata marking the systemic boundary. The problem is compounded by the widespread occurrence of early Silurian graptolitic shales devoid of shelly fossils.

The sediments of the Asker District in Norway were deposited in a depression on an epicontinental shelf where tectonic uplift or tilting partly counteracted the rapid rise in sea-level during early Silurian time (Baarli, in press). Thus, there is here a nearly continuous section of shelf sediments from the Upper Ordovician to the Lower Silurian, with a rich, shelly fauna present on both sides of the systemic boundary. A break is present near the top of the Ordovician, but it seems to be of limited duration in the Asker District. The base of the Silurian, defined at the base of the *Akidograptus acuminatus* Zone, probably occurs in the first 10 m above this diastem in the Asker District. There is therefore a continuous record across the boundary.

Levenea sp., *?Paurorthis inopinatus* sp. nov., *Epitomyonia* sp., *Drabovia* sp., *Chrustenopora askeriensis* sp. nov., *Jezerzia rongi* sp. nov., and *Ravozetina* cf. *honorata* are part of a fauna only found near the systemic boundary and studied by Baarli and Harper (1986). These elements are interpreted as Ordovician relicts belatedly suffering extinction (Baarli and Harper 1986). Baarli and Harper (1986) made only a preliminary taxonomic treatment of the fauna. Enteletaceans and orthaceans make up the main part of the relict taxa. Redesignations of the enteletacean taxa herein revealed that some of them (e.g. the genera *Drabovia*, *Jezerzia*, and *Chrustenopora*, and the species *R. honorata*) are taxa known mainly or only from Bohemia. The three last, together with *Epitomyonia*, are found in the uppermost parts of the deep-water Králův Dvůr Formation of uppermost

Rawtheyan age in Bohemia (Havlíček 1982; Havlíček and Mergl 1982). This supports the assumption of Baarli and Harper (1986) that these were elements of an immigrating deep-water fauna. It also indicates that the origin of at least many of them was Bohemian. A northward migration, because of cooling during glaciation (Spjeldnaes 1961), is possible. Deep-water faunas, however, are often relatively unaffected by climate and temperature (Cocks and Rong 1988) and cooling is probably therefore not the main reason for their migration. Such migration was stimulated instead by connections via a nearby sea-way and the development of deep-water conditions in the Oslo Region. Final extinction is interpreted as a product of competition with newly developed and more eurytopic Silurian species, like *I. prima* (Baarli and Harper 1986).

SYSTEMATIC PALAEOLOGY

Repository abbreviations. GSC, Geological Survey of Canada; GSM, British Geological Survey; PMO, Paleontologisk Museum i Oslo; UM, Museum of Paleontological Institute, University of Uppsala; USNM, United States National Museum.

Order ORTHIDA Schuchert and Cooper, 1932
 Superfamily ENTELETACEA Waagen, 1884
 Family DALMANELLIDAE Schuchert, 1913
 Subfamily DALMANELLINAE Schuchert, 1913
 Genus DALMANELLA Hall and Clarke, 1892

Type species. By original designation, *Orthis testudinaria* Dalman, 1828, p. 115, pl. 2, fig. 4.

Dalmanella cf. pectinoides Bergström, 1968

Plate 95, figs. 1–5, 10, 11, 15, 22–24

1968 *Dalmanella pectinoides* Bergström, pp. 8–9, pl. 2, figs. 6–9.

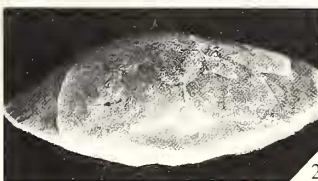
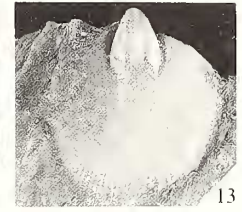
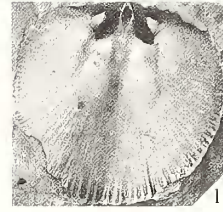
1982 *Dalmanella* sp.; Thomsen and Baarli, pl. 1, fig. 10.

1977 *Dalmanella pectinoides* Bergström; Havlíček, p. 138, pl. 32, figs. 21 and 22.

Holotype. UM Vg873: from *Dalmanitina* Beds (upper Ashgill), Bestorp, Västergötland, Sweden.

EXPLANATION OF PLATE 95

- Figs. 1–5, 10, 11, 15, 22–24. *Dalmanella cf. pectinoides* Bergström, 1968. Top of Myren Member, 17 m below base of Padda Member, Solvik Formation (basal Aeronian) at Malmøykalven. 1 and 22, PMO 20969, dorsal and frontal view of whole shell. 2, PMO 109747, internal mould of pedicle valve. 3, PMO 109753, internal moulds of two brachial valves. 4, PMO 108284, internal mould of brachial valve, figured as *Dalmanella* sp. by Thomsen and Baarli (1982, pl. 1, fig. 10). 5, PMO 109742, internal mould of brachial valve. 10, 11, 15, PMO 109754, latex cast of brachial valve. 23 and 24, PMO 109743, latex and internal mould of pedicle valve. All $\times 2$.
- Figs. 6–9, 12, 13, 16, 17, 20, 21, 25. *Isorthis (Protocortezorthis) prima* Walmsley and Boucot, 1975. 6–8, PMO 111678, Spirodden Member (top Rhuddanian), Ringeriksveien, Sandvika; ventral, dorsal, and side view of whole shell, $\times 3.5$. 9, 12, 13, 17, from base of Leangen Member, Solvik Formation (basal Aeronian), Skytterveien, Asker; 9, PMO 109730, internal mould of brachial valve; 12, PMO 103487, internal mould of brachial valve, refigured from Thomsen and Baarli (1982, pl. 1, fig. 20); 13 and 17, PMO 111673, ventral and side view of internal mould of pedicle valve; all $\times 3$. 16 and 20, PMO 105215, 10m above base of Myren Member, Solvik Formation (basal Rhuddanian), Spirodden, Asker; latex cast of mould of brachial valve, $\times 3$. 21 and 25, PMO 111725, 9 m above base of Myren Member, Solvik Formation (basal Rhuddanian), Konglungø, Asker; latex cast of internal mould of brachial valve, $\times 3$.
- Figs. 14, 18, 19. *Isorthis (Ovalella) mackenziei* Walmsley in Boucot *et al.*, 1966. PMO 108269, from base of Vik Formation (Telychian) at Kampebråten, Sandvika; latex casts (14, 19) and mould (18) of brachial valve, refigured from Cocks and Baarli (1982, pl. 3, fig. 8), $\times 2$.



Material. PMO 108284, 109742–109747, 109749, 109753, 109754, 111681–111685, 116840–116844, 116860–116870, 20968–20976, 20978, 20980–20982: internal moulds of twenty brachial, eighteen pedicle valves, and thirteen whole shells from uppermost 50 m of Solvik Formation (early Aeronian) on Malmøya (Grid Ref. NM 981376) and Malmøykalven (NM 976377) of Oslo District.

Discussion. The species is close to *Dalmanella pectinoides* Bergström, 1968, but has a lower convexity in the pedicle valve. It rarely shows the sulcus in the brachial valve and has small socket pads rather than fulcral plates, as in *D. pectinoides*. In other characteristics it agrees well, including the peculiar, almost parvicostellate ribbing. The Swedish material of *D. pectinoides* is not well preserved and shows no details of the dental system. The present material shows small teeth without cruralfossetts. Basally the teeth are supported by strong, short, and erect dental plates.

Genus RAVOZETINA Havlíček, 1974

Type species. *Orthis honorata* Barrande, 1879, p. 53, from Upper Ordovician (Králov Dvůr Formation) of Bohemia.

Ravozetina cf. *honorata* (Barrande, 1879)

Plate 96, figs. 3–6, 9, 10, 13, 14

1879 *Orthis honorata* Barrande, p. 53, pl. 68, case III, figs. 1 and 2.

1950 *Parmorthis* (*Dedzetina*?) *honorata* (Barrande, 1879); Havlíček, pp. 34–35 and 105, pl. 11, fig. 9.

1977 *Ravozetina honorata* (Barrande, 1879); Havlíček, pp. 145–147, pl. 29, figs. 7–14.

Material. PMO 111710, 111735, 116769, 116775: three brachial and one pedicle valve from Myren Member and basal 110 m of Solvik Formation of Konglungo (NM 849347), Spirodden (NM 841338), and Vakås (NM 828357).

Discussion. The species is rare and the material fragmentary. It seems to fall within the description of the type material. However, the one well-preserved brachial valve (PMO 111735) has a higher convexity than the type material.

EXPLANATION OF PLATE 96

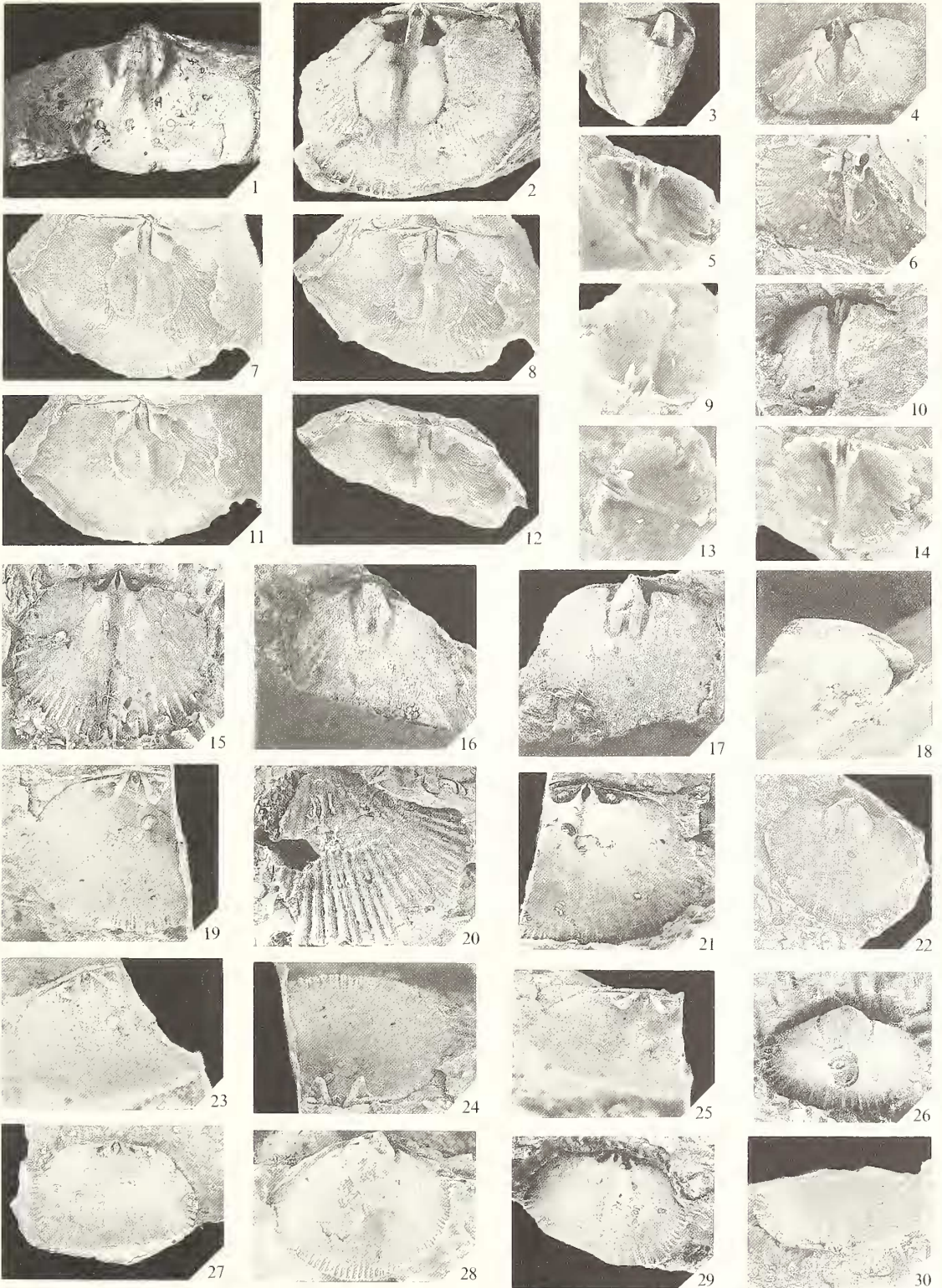
Fig. 1. *Isorthis* (*Ovalella*) *mackenziei* Walmsley in Boucot *et al.*, 1966. PMO 108270, from base of Vik Formation (Telychian) at Kampebråten, Sandvika; mould of of pedicle valve, refigured from Cocks and Baarli (1982, pl. 3, fig. 7), $\times 2$.

Figs. 2, 7, 8, 11, 12, 16–18. *Levenea* sp. nov. 2, 7, 8, 11, 12, PMO 109733, 10 m above base of Myren Member (Hirnantian/Rhuddanian), Solvik Formation, Vakås, Asker; internal mould and latex casts of brachial valve. 16–18, from 15 m above base of Myren Member, Solvik Formation, Spirodden, Asker; 16 and 18, PMO 109761, internal mould of pedicle valve; PMO 116846, internal mould of pedicle valve. All $\times 3$.

Figs. 3–6, 9, 10, 13, 14. *Ravozetina* cf. *honorata* (Barrande, 1879). 3, PMO 111710, 15 m above base of Myren Member (earliest Rhuddanian), Spirodden, Asker; internal mould of pedicle valve. 4–6, 9, 10, 13, 14, from 9 m above base of Myren Member (Hirnantian/Rhuddanian), Solvik Formation, Konglungo; 4 and 6, PMO 111735, internal mould and latex cast of brachial valve; 5, 9, 10, 13, 14, PMO 116769, latex casts and internal mould (10) of brachial valve. All $\times 3$.

Figs. 15, 19–26. *Kampella guttula* gen. et sp. nov. From base of Vik Formation (Telychian), Kampebråten, Sandvika. 15, PMO 111701, internal mould of brachial valve, $\times 3$. 19, 21, 23–25, PMO 109758, holotype, mould (21), and latex cast of brachial valve, $\times 3$. 20, PMO 111731, mould of exterior of brachial valve, $\times 3$. 22, PMO 116734, internal mould of pedicle valve, $\times 2.5$. 26, PMO 111702, internal mould of pedicle valve, $\times 2.5$.

Figs. 27–30. *Mendacella* sp. From base of Vik Formation (Telychian), Kampebråten, Sandvika. 27, 29, 30, PMO 109757, latex cast and internal mould (29) of brachial valve, $\times 2.5$. 28, PMO 109756, internal mould of pedicle valve, $\times 2.5$.



BAARLI, *Isorthis*, *Levenea*, *Ravozetina*, *Kampella*, *Mendacella*

Subfamily ISORTHINAE Schuchert and Cooper, 1931
Genus ISORTHIS Kozłowski, 1929

Type species. By original designation, *Dalmanella (Isorthis) szajnochai* Kozłowski, 1929, p. 75, pl. 2, figs. 24-41, from Borszczow Stage (early Gedinnian) of Podolia.

Isorthis (Ovalella) mackenziei Walmsley in Boucot *et al.*, 1966

Plate 94, figs. 14, 18, 19; Plate 95, fig. 1

- 1966 *Isorthis mackenziei* Walmsley in Boucot *et al.*, p. 17, pl. 4, figs. 17-20.
1975 *Isorthis (Ovalella) mackenziei* Walmsley; Walmsley and Boucot, p. 77, pl. 7, figs. 4-12.
1976 *Isorthis (Ovalella) mackenziei* Walmsley; Walmsley and Basset, p. 203, pl. 1, figs. 9-12.
1982 *Isorthis (Ovalella) mackenziei* Boucot, Johnson, Harper and Walmsley; Cocks and Baarli, pl. 3, figs. 7 and 8.

Holotype. GSC 189589 (Boucot *et al.* 1966, pl. 4, fig. 18): internal mould of brachial valve from Long Reach Formation (Late Llandovery C₆ to Early Wenlock); GSC locality 55061, southern New Brunswick, Canada.

Material. PMO 108269, 109750, 109752, 111653-111656: internal moulds of five pedicle and four brachial valves from base of Vik Formation (Telychian) at Kampebråten (NM 846402) and Chr. Skredsviks vei (NM 863428), in Sandvika.

Discussion. The material seems to fall well within the description by Walmsley and Boucot (1975) and nothing can be added from the relatively sparse and fragmentary material found here.

Isorthis (Protocortezorthis) prima Walmsley and Boucot, 1975

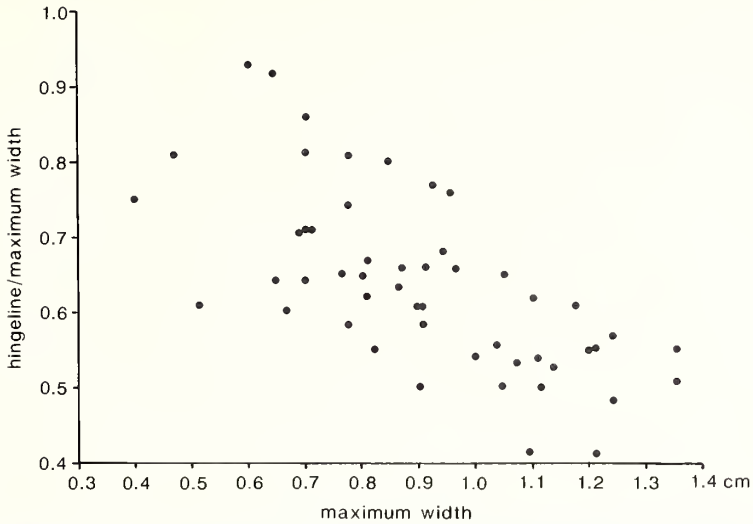
Plate 94, figs. 6-9, 12, 13, 16, 17, 20, 21, 25; text-fig. 3; table 1

- ?1917 *Orthis (Dalmanella) crassa* Lindstrom; Reed, 1917, pp. 849-850, pl. 9, figs. 8-10 (*non* Lindstrom).
1964 *Dalmanella* aff. *testudinaria* (Dalman); Boucot and Johnson, p. 3, pl. 1, figs. 1-12; pl. 2, figs. 1-7.
1975 *Isorthis (Protocortezorthis) prima* Walmsley and Boucot, p. 63, pl. 3, figs. 1-8.
1982 *Isorthis prima* Walmsley and Boucot; Thomsen and Baarli, pl. 1, fig. 20.
1986 *Isorthis prima* Walmsley and Boucot; Baarli and Harper, pl. 2, figs. *d, f*.
1987 *Isorthis prima* Walmsley and Boucot; Baarli, fig. *5d*.

Holotype. USNM 204883: pedicle valve from Mulloch Hill Formation (Rhuddanian), Rough Neuk Quarry, Craighead Inlier, Girvan, Strathclyde, Scotland (Grid Ref. NS 270040).

Material. PMO 103487, 103510, 103550, 103551, 105209, 105213-105215, 105878, 109726, 109727, 109729, 109730, 111672, 111673, 111675, 111676, 111678, 111687, 111703-111706, 111721, 111723-111726, 111728, 111729, 111738-111745, 111751, 116723-116733, 116736-116745, 116766-116768, 116845, 116856-116859, 116865, 117035, 117037, 117039, 117040, 117368-117375, 117419: internal moulds of sixty-three brachial, thirty-three pedicle, and nine whole valves found throughout Solvik Formation (Rhuddanian to early Aeronian) of Asker, Sandvika, and Malmøya areas.

Discussion. *Isorthis prima* is a very variable species, both from the type locality and in the present study area. The Norwegian material differs in that the brachial muscle scars tend to be bigger than in the type material and the brachiophores less divergent and strong. The overall variation, however, is so great that there is full overlap from region to region. Baarli (1987) listed two species from the Solvik Formation: a small one, *I. prima*, in the two lower members; and a bigger one, *Isorthis* sp., in the upper member. However, closer examination showed that all characters overlapped and I now regard both as belonging to *I. prima*. The following changes from small to larger specimens were found: 1, the hinge line changes from three-quarters to one-half of the maximum width (text-fig. 3); 2, the shape tends to change from clearly biconvex to more planoconvex; 3, the sulcus in the brachial valve is better developed in small specimens; 4, the brachiophores change from thin, slender, and sharply triangular, to ponderous and bluntly



TEXT-FIG. 3. Measurements of *Isorthis (Protocortezorthis) prima* Walmsley and Boucot, 1975, showing how the proportion of the hinge line to maximum width varies relative to size of maximum width (see Table 1).

TABLE 1. Measurements of *Isorthis prima* used in text-fig. 3 in millimetres.

PMO no.	Maximum width	Hinge line	PMO no.	Maximum width	Hinge line
103510	11.1	6.0	111737	10.5	6.8
105209	4.7	3.8	111738	6.7	4.0
105213	5.2	3.1	111744	8.2	4.5
105215	10.9	4.5	111751	7.0	5.7
105878	12.0	6.5	116723	6.0	5.6
109726	10.4	5.8	116729	9.2	6.0
109728	7.7	5.0	116731	4.0	3.0
109730	8.1	5.4	116732	12.2	5.0
111672	12.5	6.0	116845	9.0	4.5
111672	11.0	6.8	116855	7.8	4.5
111673	13.5	7.5	117035	9.3	7.2
111675	10.5	5.2	117037	10.8	6.0
111678	9.1	5.3	117039	7.8	5.8
111687	11.8	7.2	117040	6.5	6.0
111703	8.8	5.8	117368	9.5	6.5
111704	8.1	5.1	117370	9.0	5.5
111705	9.1	5.5	117371	10.0	5.4
111706	9.8	6.5	117372	7.0	6.0
111723	8.0	5.2	117373	7.8	6.3
111724	6.6	4.2	117374	7.0	5.0
111725	8.5	6.8	117375	7.0	4.5
111726	12.5	7.2	117377	9.5	7.2
111728	6.8	4.8	117378	7.0	5.0
111729	11.2	5.6	117419	13.5	6.8
111736	8.7	5.5			

triangular; 5, the fulcral plates are more pronounced in the larger specimens; and 6, the muscle fields are better impressed with muscle bounding ridges tending to curve on to the median ridge.

Genus *LEVENEAE* Schuchert and Cooper, 1931

Type species. By original designation, *Orthis subcarinata* Hall, 1857, p. 43, figs. 1 and 2.

Levenea sp. nov.

Plate 96, figs. 2, 7, 8, 11, 12, 16-18

Material. PMO 109733, 109760, 109761, 116846, 117400: internal moulds from three pedicle valves and two brachial valves from basal Solvik Formation at Spirodden (NM 841338), Konglungo (NM 849347), and Vakås (NM 828357) in Asker area.

Description. Exterior: subcircular biconvex to ventribiconvex and four-fifths as long as wide. Hinge line straight and three-quarters as long as maximum width, which occurs at mid-length. Cardinal angle obtuse, commissure gently and evenly curved. Beak straight and delthyrium and notothyrium open. Finely costellate with four or five rounded ribs per mm. Weak, broad sulcus in brachial valve.

Interior of pedicle valve: delthyrial chamber narrow and high with relatively flat floor. Simple, triangular, and very strong teeth. Very short, curved dental plates continue into well-developed muscle-bounding ridges, which delimit narrowly bilobate and strongly impressed muscle scars. Muscle scars pentagonal, occupy two-fifths of total length, and divided anteriorly by narrow and diverging median ridge originating at half length of muscle scars. Vascula media initially nearly parallel, then diverges and strongly branches.

Interior of brachial valve: brachiophores ponderous and swollen medially with supporting plates more divergent at base than at top. Socket pads present. Cardinal process bulbous and bilobed with long broad shaft. Muscle field well impressed with strong muscle-bounding ridges. Broad parallel-sided and shallow myophragm ends at anterior end of muscle scars. Muscle scars occupy two-fifths of total length, divided by straight transverse ridges in small subquadrate posterior scars and larger suboval anterior scars.

Discussion. This material is close to *Levenea media* (Shaler, 1865), as redescribed by Walmsley and Boucot (1975). It is distinguished by less well-developed socket pads, a smaller cardinal process,

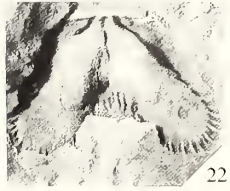
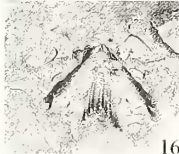
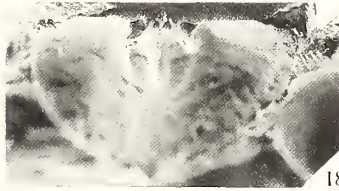
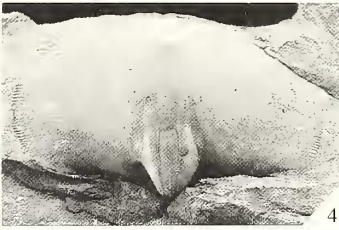
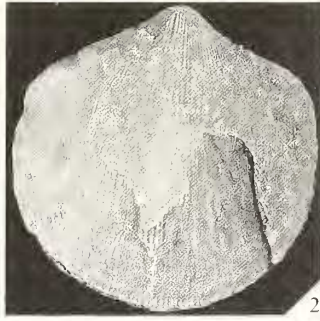
EXPLANATION OF PLATE 97

Figs. 1-5, 10, 11, 14, 15, 18, 19. *Resserella matutina* sp. nov. 1, 2, 5, PMO 52924, Leangen Member, Solvik Formation (early Aeronian), Vetre Brygge, Asker; dorsal, ventral, and side views of whole shell, $\times 2.5$. 3, 4, 10, 11, 14, 15, 18, 19, from top of Leangen Member, Solvik Formation (middle Aeronian). 3, 14, 15, 18, PMO 111716, Avløes, Bærum; internal mould of brachial and pedicle valve (3), and latex cast of the brachial valve, $\times 2$. 4, PMO 111719, Gjetlum, Bærum; internal mould of pedicle valve, $\times 2$. 10, PMO 108288, Gjetlum, Bærum; holotype, internal mould of brachial valve, refigured from Thomsen and Baarli (1982, pl. 1, fig. 22). 11 and 19, PMO 111717, Avløes, Bærum; ventral and posterior view of internal mould of pedicle valve, $\times 2$.

Figs. 6-9, 13, 21-26. *Dicoelosia osloensis* Wright, 1968a. 6, PMO 103510, 42 m above base of Leangen Member, Solvik Formation (middle Aeronian), Skytterveien, Asker; internal mould of pedicle valve. 7 and 8, from basal 10 m of Leangen Member, Solvik Formation (early Aeronian), Skytterveien, Asker; 7, PMO 105890, internal mould of brachial valve, refigured from Baarli (1987, fig. 5c); 8, PMO 105222, internal mould of pedicle valve, refigured from Thomsen and Baarli (1982, pl. 1, fig. 15). 9, 13, 21, 23-26, basal 10 m of Leangen Member, Solvik Formation (early Aeronian), Leangbukta, Asker; 9, PMO 116763, ventral view of external mould; 13, PMO 111732, internal mould of brachial valve; 21, 23-26, PMO 116756, latex and internal mould (24) of brachial valve. All $\times 4$.

Figs. 12, 16, 17. *Dicoelosia alticavata* (Whittard and Barker, 1950). From base of Vik Formation (Telychian), Kampebråten, Sandvika. 12, PMO 111671, internal mould of pedicle valve. 16, PMO 111698, internal mould of brachial valve. 17, PMO 108261, internal mould of pedicle valve, refigured from Cocks and Baarli (1982, pl. 3, fig. 6). All $\times 4$.

Fig. 20. *Epitomyonia* sp. PMO 108287, base of Myren Member, Vakås, Asker; internal mould of pedicle valve, refigured from Thomsen and Baarli (1982, pl. 1, fig. 16) and Baarli and Harper (1986, pl. 2k), $\times 3$.



and larger muscle scars in the brachial valve. The pedicle valve shows a rounder and narrower median ridge between the diductor scars. *L. media* was the oldest known species of *Levenea* (Idwian time). This material belongs to a new species and also predates it. Additional material is needed, however, to formally erect a new species.

Subfamily RESSERELLINAE Lazarev, 1970

Genus RESSERELLA Bancroft, 1928

Type species. By original designation, *Orthis canalis* J. de C. Sowerby in Murchison, 1839, p. 630 *pars.* pl. 13, fig. 12a, *non* pl. 20, fig. 8.

Resserella matutina sp. nov.

Plate 97, figs. 1-5, 10, 11, 14, 15, 18, 19

1982 *Resserella* sp. Thomsen and Baarli, pl. 1, fig. 22.

Holotype. PMO 108288 (Pl. 97, fig. 10): brachial valve from upper part of Leangen Member, Solvik Formation (middle Aeronian) at Gjettem in Bærum (NM 856421).

Material. 52924 (twelve specimens), 53203, 53204, 53206, 108288, 109755, 111652, 111680, 111716-111719, 113669-113676, 116848-116854: seventeen whole shells, eighteen pedicle, and six brachial valves from top of Solvik Formation (early to middle Aeronian) at Gjettem (NM 856421), Jongsåskollen (NM 846404), Avløs (NM 868431) in Sandvika and Vetre Brygge in Asker.

Diagnosis. Transversely elliptical, planoconvex to concavoconvex with fine ribbing of elegantuloid type. Ventral beak overhanging straight hinge line. Ventral muscle field well impressed and pentagonal with vascula media divergent. Teeth strong with deep cruralfossetts. Anacline interarea and shallow, broad sulcus in brachial valve. Brachiophore processes strong, tusk-like, and with relatively small sockets for the genus. Muscle scars well impressed with posterior adductor scars larger than anterior.

Description. Exterior: planoconvex to concavoconvex with very deep pedicle valve relative to brachial valve. Outline transversely shield-shaped, with length three-quarters of width. Maximum width varies, 15-22 mm. Hinge line long and straight, equal in length to three-quarters to four-fifths of maximum width. Cardinal angle rounded, lateral and anterior margins evenly rounded. Commissure evenly rounded and anterior commissure gently sulcate. Brachial valve bears broad, shallow sulcus originating near hinge line and widening anteriorly. Ventral beak incurved, most often overhangs hinge line, and projects posteriorly about one-fifth of total length of valve. Ventral interarea apsacline and gently concave. Delthyrium open with delthyrial angle *c.* 60°. Dorsal interarea plane, anacline. Notothyrium open and occupied by myophore of cardinal process. Ornament multicostellate, fine with four or five ribs per mm at 5 mm growth stage of brachial valve. Costellae low, rounded, and evenly spaced. Ribbing style of elegantuloid type.

Interior of pedicle valve: delthyrial chamber deep with wide flat floor anteriorly. Very strong teeth with cruralfossetts and triangular dorsal faces supported basally by short dental plates which diverge at *c.* 60° from each other anterolaterally. Dental plates continue anteriorly into low ridges which define muscle field laterally and converge slightly but do not define muscle field anteriorly. Muscle field variably impressed, elongate pentagonal in outline, and occupies about one-third of total length of pedicle valve and one-quarter of width. Adductor scars raised anteriorly on broad low ridge that descends at angle to floor of valve, producing a distinct edge. Diductor scars narrow and elongate. Vascula media divide anteriorly.

Interior of brachial valve: cardinal process bulbous with short shaft. Brachiophores strong, tusk-like, and erect. Tops of supporting plates diverge at 80° to one another and relative to bases. Posterolateral sides of brachiophores with supporting plates triangular, anterior sides normal to floor of valve. Sockets supported by small socket pads. Muscle field raised, quadripartite to subelliptical in outline; occupies about one-half of valve length and one-quarter of width; and bound laterally by low, curved ridges, which are continuations of brachiophore bases and which converge anteriorly but do not meet myophore. Muscle field bisected by rounded, broad myophore, which continues anteriorly beyond muscle field. Faint transverse ridges separate triangular anterior muscle field from much smaller subquadrate posterior muscle field.

Discussion. This species is the oldest known Silurian *Resserella* and it occurs from the lowest Aeronian. It seems to be a form transitional between *Karlicium* Havlíček, 1974 (an Ordovician genus previously proposed as its predecessor by Havlíček 1977), and *Resserella* (thus supporting Havlíček's claim). The fine resserellid ribbing, the strongly impressed muscle-bounding ridges, and the anacline interarea of the brachial valve connect it with *Resserella*. The transverse outline, diverging vascula media, and the anterior pair of adductor scars which are larger than the posterior pair, are features typical of *Karlicium*. Except for the diverging vascula media, all these features are also found in some other species of *Resserella*, so the assignment to *Resserella* is reasonable. *R. matutina* sp. nov. is distinguished from the slightly younger *R. sefinensis* Walmsley and Boucot, 1971, by finer costellae, less diverging brachiophores, and its resupinate form. *R. concavoconvexa* (Twenhofel, 1928), which first occurs in a C₃ to C₄ position, has the same outline but differs in its vascula media and hypercline interarea (as opposed to the anacline interarea of the brachial valve of *R. matutina* sp. nov.).

Family RHIPIDOMELLIDAE Schuchert, 1913
Subfamily RHIPIDOMELLINAE Schuchert, 1913
Genus MENDACELLA Cooper, 1930

Type species. By original designation, *Orthis uberis* Billings, 1866, from Ellis Bay Formation (Ashgill), Anticosti Island, Quebec, Canada.

Mendacella bleikeriensis sp. nov.

Plate 98, figs. 1-6, 9, 11, 13-15

1982 *Mendacella* cf. *mullockiensis* (Davidson); Thomsen and Baarli, pl. 1, figs. 13 and 14.

1987 *Mendacella* sp.; Baarli, fig. 5c.

Holotype. PMO 105221 (Pl. 98, figs. 1-3, 9): internal mould of brachial valve from 60-70 m above base of Leangen Member (mid-Aeronian), Solvik Formation, Skytterveien (NM 820339), in Asker.

Material. PMO 103476, 105217-105219, 105221, 108286, 109740, 109741, 111688, 111689, 111730, 111746, 113715-113719, 116747: moulds of nine pedicle and eight brachial valves and four whole shells. Species found rarely in Spirodden Member (Rhuddanian), but occurs frequently in upper 30 m of Leangen Member (early Aeronian), Solvik Formation, both in Asker and Sandvika.

Diagnosis. Transverse subelliptical *Mendacella* with deep, nonsulcate brachial valve and low pedicle valve with variably developed sulcus. Ribbing finely multicostellate. Triangular teeth with cruralfossetts. Strongly impressed nonflabellate to flabellate muscle field tending to enclose adductor muscle scars. Slender, widely divergent, and curved brachiophores with short supporting bases. Variably developed crural pits. Weakly impressed dorsal muscle scars.

Description. Exterior: dorsibiconvex, transverse subelliptical, and about five-sixths as long as broad with width 11-20 mm. Pedicle valve bears variably developed, often strong and broad sinus, originating at length about one-third from posterior margin and occupying half of width. Hinge line straight, about half as long as maximum width, which occurs at three-quarters length from posterior margin. Commissure crenulated. Cardinal angle gently rounded, lateral margins rounded for posterior half of valve, then nearly parallel before passing into anterior sulcus. Ventral beak short, low, and gently incurved. Delthyrium and notothyrium open. Ventral interarea gently apsacline; dorsal interarea anacline and very low. Ornament finely multicostellate with three or four rounded costellae per mm at 5 mm growth stage of brachial valve.

Interior of pedicle valve: delthyrial chamber low with flat floor anteriorly. Pedicle callist present. Well-developed triangular teeth with small cruralfossetts. Low shallow ridges extend anteriorly from short dental plates and bound muscle fields laterally. Muscle fields strongly impressed, occupying half of total length. Clearly impressed small, elliptical, elongate adductor scars on rounded median ridge bounded and enclosed by broad cordate diductor scars which may be faintly flabellate.

Interior of brachial valve: brachiophores with supporting plates widely divergent at 90-110°, bluntly

triangular, and inclined anterolaterally. May have receding socket pads. Cardinal process consists of long, slender shaft with bilobed, sometimes expanded myophore. Very weakly impressed muscle-bounding ridges. Dorsal muscle fields subcircular, about equally quadripartite, and occupy two-fifths of total length and width. Low, broadly rounded median ridge tapers and extends anteriorly to anterior of muscle scars. Periphery of dorsal valve bears low, rectangular crenulations complementary to those of pedicle valve.

Discussion. Boucot *et al.* (1965) defined the differences between *Mendacella* and *Dalejina* as: non-enclosed adductor scars and non-flabellate diductor scars in the pedicle valve of the former; and enclosed adductors with flabellate diductors in the latter. Some of the material discussed above should thus fall within *Dalejina*. However, some of the material figured as *Mendacella* by Boucot *et al.* (1965) have the same enclosed adductor scars and faintly flabellate diductor scars as the Norwegian specimens.

The new species is close to *M. nullockiensis* (Davidson, 1869). This species was recently reinvestigated by Temple (1987). He assigned all the abundant early Llandovery enteletaceans from Wales to *M. nullockiensis*, including: *M. nullockiensis* (Davidson, 1869), *M. crassiformis* Bancroft, 1949, *R. llandoveryana* Williams, 1951, and *I. prima* Walmsley and Boucot, 1975. The new species lies close to his *M. nullockiensis* morph. *nullockiensis* which I regard as a separate species. However, *M. bleikeriensis* differs from *M. nullockiensis* in having more slender and curved brachiophores, shorter brachiophore bases, lack of sulcus in dorsal valve (which most specimens of *M. nullockiensis* have), generally smaller ventral muscle scars, occurrence of crural pits, and slightly coarser ribbing.

Mendacella sp.

Plate 96, figs. 27-30

1982 *Mendacella* sp.; Cocks and Baarli, pl. 2, figs. 7 and 8.

Material. PMO 109756, 109757, 111659, 111663: internal moulds of three brachial valves and one pedicle valve, from base of Vik Formation (Telychian) at Kampebråten (NM 848404) in Sandvika.

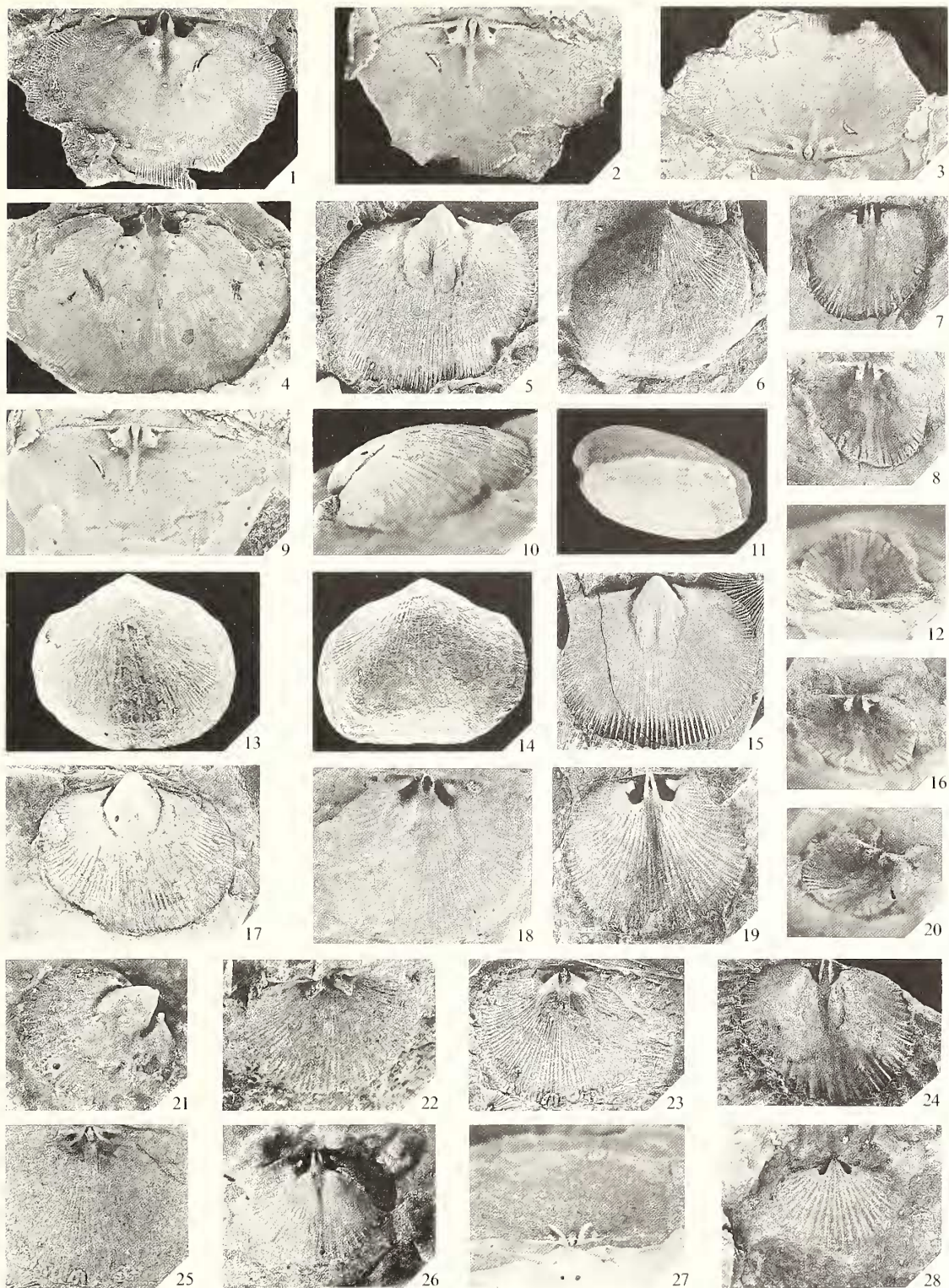
Discussion. The material is so scarce and badly preserved that the species is best left undetermined.

EXPLANATION OF PLATE 98

Figs. 1-6, 9, 11, 13-15. *Mendacella bleikeriensis* sp. nov. 1-6, 9, 15, from 60-70 m above base of Leangen Member, Solvik Formation, Skytterveien, Asker; 11, 13, 14, middle of Leangen Member, Solvik Formation (lower parts of Aeronian), E6 near Vakås, Asker. 1-3, 9, PMO 105221, holotype, internal mould and latex cast of brachial valve; 4, PMO 103476, internal mould of brachial valve, refigured from Baarli (1987, fig. 6c); 5, PMO 108286a, internal moulds of pedicle valves (deposited with 108286b); 6, PMO 111688, exterior of pedicle valve; 15, PMO 108286b, side and posterior view of internal mould of pedicle valve, refigured from Thomsen and Baarli (1982, pl. 1, fig. 14). 11, 13, 14, PMO 111730, side, dorsal, and ventral views of valve. All $\times 2$.

Figs. 7, 8, 12, 16, 20, 24. *Drabovia* sp. 7, 8, 12, 16, 20, PMO 111708, 17 m above base of Myren Member, Solvik Formation (earliest Rhuddanian), Vakås, Asker; internal mould (7) and latex of brachial valve, $\times 4$. 24, PMO 109709, 9 m above base of Myren Member, Konglungo, Asker; internal mould of brachial valve, refigured from Baarli and Harper (1986, fig. 2e), $\times 4$.

Figs. 10, 17-19, 21-23, 25-28. *Marklandella markesi* sp. nov. From middle (30-40 m above base) of Leangen Member, Solvik Formation (early to mid-Aeronian), Leangbukta, Asker. 10, 17, PMO 105206, holotype, lateral and posterior view of internal mould of pedicle valve, refigured from Baarli (1987, fig. 6h). 18, 23, 25, 27, PMO 105208, internal mould and latex cast of brachial valve. 19, PMO 105205, internal mould of brachial valve, refigured from Baarli (1987, fig. 6f). 21, PMO 103545, internal mould of pedicle valve. 22, PMO 109751, latex cast of brachial valve. 26, PMO 103533, internal mould of brachial valve. 28, PMO 103504, internal mould of juvenile brachial valve. All $\times 3$.



BAARLI, *Mendacella*, *Drabovia*, *Marklandella*

Family HETERORTHIDAE Schuchert and Cooper, 1931
Genus MARKLANDELLA Harper, Boucot and Walmsley, 1969

Type species. By original designation, *Marklandella giraldi* Harper, Boucot and Walmsley, 1969, p. 83, pl. 17, figs. 1-10, from Silurian (Wenlock or Ludlow) of Freshwater East Bay, Dyfed, Wales.

Marklandella markesi sp. nov.

Plate 98, figs. 10, 17-19, 21-23, 25-28

1987 *Marklandella* sp.; Baarli, fig. 6f, h.

Holotype. PMO 105206 (Pl. 98, figs. 10 and 17): internal mould of pedicle valve from bulk sample taken 40 m above base of Leangen Member, Solvik Formation (mid-Aeronian), at innermost part of Leangbukta in Asker.

Material. PMO 103504, 103533, 103545, 105206-105208, 109751, 113720-113723, 116748-116752: moulds of sixteen brachial and nine pedicle valves from Leangen Member (mid-Aeronian) of Solvik Formation at Leangbukta (NM 825341) in Asker.

Diagnosis. Planoconvex and subcircular with fine multicostellae. Adductor scars of pedicle valve visible and not enclosed by the diductor scars. Brachiophores small, slender, and very divergent. No socket pads. Dorsal muscle scars very faintly or not impressed, with posterior muscle scars smaller than anterior. Costellae impressed over the entire interior of the valve.

Description. Exterior: planoconvex with circular to transversely elliptical outline, 6-15 mm wide. Hinge line straight, three-fifths maximum width (which occurs posterior to midlength). Brachial valve may bear shallow sulcus anteriorly. Cardinal angles rounded. Lateral and anterior margins evenly rounded. Ventral beak low, gently curved, and projects slightly beyond hinge line. Ventral interarea apsacline; dorsal interarea anacline, very short. Delthyrium and notothyrium open. Ornament fine multicostellate with three or four costellae per mm at 5 mm length growth stage of brachial valve. Costellae rounded, equally spaced, and radiate with some curvature.

Interior of pedicle valve: delthyrial chamber shallow with concave floor. Pedicle callist present. Teeth small and supported by slender, faintly inclined, and curved dental plates. Dental plates extend anteriorly to about midlength of muscle field, where they join a shallow ridge which curves and defines diductor muscle field anteriorly. Muscle field weakly impressed and cordate in outline, occupies nearly half total valve length, and is about four-fifths as wide as long. Adductor scars low and elongate in outline and not bound anteriorly by diductor scars. Diductor scars subtriangular and elongate. Internal surface of valve impressed by costellae.

Interior of brachial valve: brachiophores small and slender; tops of supporting plates diverge slightly more posterolaterally than bases. Lateral view of brachiophores with supporting plates is bluntly triangular and concave. Supporting plates diverge at *c.* 80-100° from one another at top. Cardinal process varies in outline from very thin, simple ridge to expanded and possibly three- to four-lobed myophore. Sockets are level with floor of valve. Muscle fields most often not impressed, but when visible they occupy nearly half of total valve length; they are quadripartite with posterior muscle scars bigger than anterior. Muscle scars are divided by low, broad median ridge which tapers anteriorly. Anterior crenulations rounded in cross-section; impression of costellae extend posteriorly to muscle field.

Discussion. This species is close to the other two known species: *M. giraldi* Harper *et al.*, 1969 and *M. macadamia* Harper *et al.*, 1969. The new species differs in having slightly coarser ribbing, very slender and commonly more divergent brachiophores, and faintly impressed muscle scars which exhibit anterior scars larger than the posterior.

Genus KAMPELLA gen. nov.

Type species. *Kampella guttula* sp. nov.

Diagnosis. Shell biconvex and subcircular with relatively short hinge line. Ribbing costellate and costellae situated in posterior portion of shell recurving posteriorly to intersect posterior valve margin. Small ventral umbo. Ventral muscle scars widely cordate with diductor lobes extending

beyond and not enclosing adductor scars. Vascula media moderately divergent. Brachiophores with bases widely diverging relative to top and to each other. No fulcral plates. Cardinal process expanded in semiovoid structure. Vascula terminalia occurring along hinge line are posteriorly directed.

Discussion. This genus is close to both *Omiella* and *Heterorthina*. It is distinguished from *Omiella* by the possession of features that characterize the Heterorthidae, as redefined by Havlíček (1970), e.g. its posteriorly recurving costellae, the vascula terminalia directed posteriorly on the posterior part of the brachial valve, and fairly large muscle scars. It is distinguished from *Heterorthina* by the fact that the ridges limiting the ventral diductor scars do not unite anteromedially to enclose the adductor scars, and because the vascula media is only moderately divergent (like *Omiella*). In addition, the brachiophore bases are so greatly divergent that their posterior surfaces acted as walls to the sockets, as seen typically in *Bancroftina* and rarely in *Omiella*, but not in *Heterorthina*.

Kampella guttula sp. nov.

Plate 96, figs. 15, 19–26

Holotype. PMO 109758: mould of brachial valve (Pl. 96, figs. 19, 21, 23–25) from base of Vik Formation (Telychian) of Kampebråten in Sandvika (NM 848404).

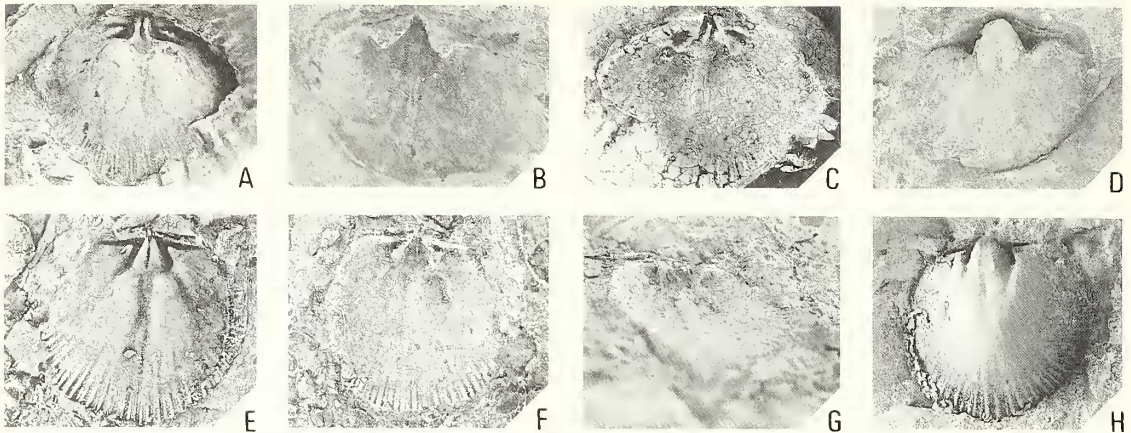
Material. PMO 109758, 111657, 111660, 111661, 111669, 111697, 111699, 111701, 111702: seven brachial and five pedicle valve moulds from base of Vik Formation (Telychian) of Kampebråten (NM 848404) and Chr. Skredsvik vei (NM 863428) in Sandvika.

Diagnosis. Biconvex, with strongest convexity posterior, gradually flattening out anteriorly. Fascicostellate. Both muscle fields faintly impressed. Ventral muscle field broadly cordate, occupying less than half of length of valve and displaying broad, slightly elevated median ridge. Hinge line straight and relatively short. Strong triangular teeth with well-developed cruralfossets. Strong brachiophores with bases greatly divergent relative to their tops and to each other. Well-developed sockets. Cardinal process expanded in ovoid structure. Quadripartite muscle scars with small posterior scars relative to anterior scars.

Description. Exterior: transversely elliptical, biconvex, three-fifths to five-sixths as long as wide, with maximum width 7–15 mm. Hinge line straight, two-fifths to three-fifths of maximum width. Commissure crenulated. Cardinal angles and lateral commissure rounded, anterior commissure gently rounded. May have shallow sulcus. Ventral beak incurved and slightly overhanging hinge line. Delthyrium and notothyrium open. Fascicostellate with two or three first order costellae per mm at 5 mm growth stage of brachial valve and much finer second order costellae superimposed. Exopunctate. Costellae in posterior part of valve recurve posteriorly to intersect posterior margin of shell. Both pedicle and brachial valve with strongest convexity posterior, and clear change in convexity one-third in length from posterior end.

Interior of pedicle valve: delthyrial chamber strongly concave. Strong, triangular teeth with very well-developed cruralfossets. Short dental plates which continue into shallow ridges and define muscle field laterally; they curve but do not close completely anteriorly. Variably impressed muscle field occupying less than half of valve length. Narrow, triangularly elongate adductor scars on broad, slightly raised median ridge, bounded laterally by broad, triangular diductor scars not enclosing adductor scars. Greatly divided and moderately divergent vascula media. Quadripartite muscle scars with posterior scars smaller than anterior scars.

Interior of brachial valve: brachiophores erect. Tops of supporting plates diverge at 30–45° relative to each other. Bases much more diverging than tops. Sockets large and triangular with brachiophore bases acting as anterior walls supported by secondary shell deposits. Muscle field faintly impressed, especially anteriorly; it occupies less than half of valve length and one-third of maximum valve width. Posterior adductor fields subquadrate and small, while anterior scars seem larger and weakly defined. The myophragm is nonexistent to broad, shallow and tapering. Transverse muscle-bounding ridges straight and faintly impressed. Cardinal process has short shaft, is erect, and widest at middle. Vascula terminalia occurring along hinge line are posteriorly directed.



TEXT-FIG. 4. A–D, *Paurorthis inopinatus* sp. nov. Earliest Rhuddanian, Solvik Formation, Asker. A, C, PMO 109731, holotype, 10 m above base of Myren Member, Vakås, Asker; internal mould and latex of brachial valve, $\times 3$. B, D, PMO 111733, 9 m above base of Myren Member, Konglungø; latex and internal mould of pedicle valve, $\times 3$. E–H, *Enteletacea* indct. sp. A. Solvik Formation, Asker. E–G, PMO 103498, middle of Leangen Member (early Aeronian), Skytterveien; internal mould and latex cast of brachial valve, $\times 2$. H, PMO 105216, middle of Spirodden Member (late Rhuddanian), Spirodden; internal mould of pedicle valve, $\times 2$.

Family PAURORTHIDAE Öpik, 1933
Genus PAURORTHIS Schuchert and Cooper, 1931

Type species. By original designation, *Orthambonites parva* Pander, 1830, from Lower Ordovician of Estonia.

?*Paurorthis inopinatus* sp. nov.

Text-fig. 4A–D

Holotype. PMO 109731: mould of brachial valve (text-fig. 4A, C), from 10 m above base of Myren Member (earliest Rhuddanian), Solvik Formation, Vakås (NM 828357) in Asker.

Material. PMO 109731, 111712, 111733, 116735: moulds of three brachial and one pedicle valves from Myren Member (earliest Rhuddanian), Solvik Formation, Konglungø (NM 849347) and Vakås (NM 828357) in Asker.

Diagnosis. *Paurorthis* with deep notothyrial cavity, ridge-like cardinal process, moderately developed median ridge, and long elongate posterior muscle scars lying laterally to anterior scars in brachial valve. Pedicle valve with broad median ridge extending to anterior margin, and very strong teeth.

Description. Exterior: biconvex, subcircular equal to nine-tenths as long as wide. Hinge line straight, two-thirds to three-quarters as long as maximum width. Maximum width 6–10 mm occurring posterior of midlength. Cardinal angles obtuse, margins evenly rounded. No clear folds or sulcus. Beak small and straight. Ventral interarea apsacline. Short anacline dorsal interarea. Delthyrium and notothyrium open. Fascicostellate, four or five costellae per mm at anterior margin.

Interior of pedicle valve: no pedicle callist. Strong, ponderous, and bluntly triangular teeth with obsolete dental plates. Faint muscle-bounding ridges define muscle scars laterally and verge on to median ridge. Lanceolate adductor scars situated on broad median ridge. Ridge continues to anterior margin and is bounded by narrow, triangular diductor scars, and more anteriorly by vascula media, which thus is parallel.

Interior of brachial valve: brachiophores simple and ridge-like. Supporting plates, with bases strongly diverging relative to tops, act as anterior wall of sockets. Angle between tops of supporting plates 40° . Large specimens have well-developed notothyrial platforms. Thin, ridge-like cardinal process. Moderately developed median ridge extending to anterior end of muscle scars. Muscle scars large and faintly impressed with

posterior scars situated laterally to anterior scars. They are divided by strongly oblique ridges diverging anterolaterally. Muscle scars occupy half of total valve length and width.

Discussion. *P. inopinatus* undoubtedly belongs to the Paurorthidae. It has all the features of *Paurorthis*, including the simple ridge-like cardinal process, obsolete dental plates, and dorsal muscle scars divided by oblique ridges. However, the median ridges both in the pedicle and in the brachial valves are weakly developed; likewise, the notothyrial platform is not as high as in typical *Paurorthis*. These differences might justify erecting a new genus, but the available material is not adequate. Havlíček *et al.* (1986) found what they called 'probably the last occurring *Paurorthis*' at Fluminimaggiore, Sardinia, of uppermost Berounian (= lowermost Ashgill) age. However, the new species described here occurs considerably later.

Family DICOELOSIIDAE Cloud, 1948

Genus DICOELOSIA King, 1850

Type species. By original designation, *Anomia biloba* Linnaeus, 1758, p. 703.

Dicoelosia osloensis Wright, 1968a

Plate 97, figs. 6-9, 13, 21-26

1968a *Dicoelosia osloensis* Wright, pp. 309-311, pl. 5, figs. 6-11; pl. 6, figs. 7-10.

1968 *Dicoelosia verneuliana* (Bucher); Amsden, pl. 8, fig. 1.

1971 *Dicoelosia* aff. *osloensis*; Rubel, p. 51, pl. 8, figs. 18-25.

1971 *Dicoelosia osloensis*; Rubel, p. 53, pl. 9, figs. 1-5, 14.

1982 *Dicoelosia osloensis* Wright; Thomsen and Baarli, pl. 1, fig. 15.

1986 *Dicoelosia osloensis* Wright; Baarli and Harper, pl. 2i.

1987 *Dicoelosia osloensis* Wright; Baarli, fig. 5c.

1987 *Dicoelosia osloensis* Wright; Temple, p. 49, pl. 3, figs. 10-12.

Holotype. PMO 74564: conjoined valves, from *Bilobites biloba* shale, Myren Member, 20-50 m below base of Padda Member (early Llandovery), Solvik Formation, Malmoya, Inner Oslo Fjord.

Material. PMO 87609, 103468, 103510, 105886, 105890, 111732, 113724, 113677-113714, 116756-116765, 117381-117386: twenty-nine brachial and forty-seven pedicle valves and four whole shells from Solvik Formation, Asker and Malmoya.

Description. Exterior. Wright (1968a) defined the species as typically broader than long. Maximum width, however, seems to vary allometrically with length. Small specimens often broader than long (see Pl. 97, fig. 9). Relationship between maximum length and length to lobe is apparently constantly 4:3, as found at Malmoya. Great variation in external shape of *Dicoelosia osloensis* is in accordance with what Rubel (1971) and Musteikis and Puura (1983) found for Estonian and Lithuanian material.

Wright (1968a) noted that the species probably did not have well-developed ribs on the sulcus. This present material clearly shows ribs, although not as strongly developed as on top of lobes.

Interior of pedicle valve: form of delthyrial chamber seems to vary ontogenetically. Small forms tend to have flatter and shallower floor in chamber than larger specimens, thus producing change in profile posteriorly from gently curving in small forms to steeply descending in large forms. No pedicle callist. Teeth small with cruralfossetts. Dental plates very short, continuing in low ridges that run parallel, delimiting muscle scars laterally. Muscle field occupying one-quarter to one-fifth of total valve length and often situated on thickened floor. Thickening sometimes bounded anteriorly by wedge giving bilobed impression. Median ridge present and varies in width from width of one diductor scar to thin ridge. In former case, ridge longitudinally striated.

Interior of brachial valve: myophore short, bilobed, and often greatly expanded and crenulated; it fills notothyrium. Myophore shaft continues in variably developed median ridge which may be high and sharp and extend to anterior invagination, or may appear as broad elevated median area not clearly delimited. Brachiophore bases continue from thickened notothyrial walls and are greatly divergent relative to tops of supporting plates. Small sockets and small 'swellings' or hook-like brachiophores directed posterolaterally. Muscle scars very well-developed and occupy most of space posterior to invagination. Both scars narrowly elongate and divided by faint, very oblique ridge diverging towards lateral margins. Posterior scar may extend

nearly equally far anteriorly as anterior scar, and slightly past invagination. Adductor muscle scars engulf lanceolate area and start very far posteriorly where they are delimited by brachiophore bases. Follicular eminences and embayments very well developed.

Discussion. The type species was described from the Solvik Formation at Malmøya in the Oslo District. The material, however, was distorted and only exterior features were described. The Asker District provides rich material of the species from the Solvik Formation, with well-preserved internal features and structures. Additional information and a partial redescription of the species therefore is presented above.

Dicoelosia alticavata (Whittard and Barker, 1950)

Plate 97, figs. 12, 16, 17

- 1950 *Bilobites alticavatus* Whittard and Barker, p. 577, pl. 8, figs. 16-18.
 1968a *Dicoelosia alticavata* (Whittard and Barker); Wright, p. 311, pl. 2, figs. 11-15.
 1974 *Dicoelosia alticavata* (Whittard and Barker); Bassett and Cocks, p. 11.
 1982 *Dicoelosia alticavata* (Whittard and Barker); Cocks and Baarli, pl. 3, fig. 15.

Holotype. GSM 82551: conjoined valves from Purple Shales (Telychian), 200 m north-north-east of Hughley Bridge, Shropshire (SO 562979).

Material. PMO 108261, 111667, 111671, 111691, 111693, 111695, 111696, 111698, 117410-117412: one external mould and nine pedicle and two internal moulds of brachial valves from basal Vik Formation (Telychian) at Kampebråten in Sandvika.

Discussion. The species is rather rare and not well preserved, so it provides little new information. Wright (1968a), however, remarks that ribs are probably only weakly developed in the sulcus. This material show the feature is well developed.

Genera EPITOMYONIA Wright, 1968b

Type species. By original designation, *Epitomyonia glypha* Wright, 1968b, p. 128, pl. 1, figs. 1-5.

Epitomyonia sp.

Plate 97, fig. 20

- 1982 *Dicoelosia* cf. *inghami* Wright; Thomsen and Baarli, pl. 1, fig. 16.
 1986 *Epitomyonia* sp.; Baarli and Harper, pl. 2, fig. k.

Material. PMO 108287, 117407-117409: five pedicle valves (two moulds and three exterior shells) from 0-3 m above base of Myren Member (Hirnantian/Rhuddanian), Solvik Formation, Vakås in Asker (NM 828357).

Description. Exterior: only pedicle valves known. These are high, convex, and subquadrate. Width varies from half to five sixths of total length. Hinge line long and straight, five-sixths of maximum length. There might be a slight invagination anteriorly. Very shallow sulcus best seen in moulds. Ears very small. Ribbing costellate, three ribs per mm, measured 5 mm in front of umbo.

Interior of pedicle valve: small, pentagonal, and faintly impressed muscle scars occupy one-fifth of total length. Broad median ridge separates triangular diductor muscle scars. Small teeth and weakly developed muscle-bounding ridges.

Family DRABOVIINAE Havlíček, 1950

Genus DRABOVIA Havlíček, 1950

Type species. By original designation, *Orthis redux* Barrande, 1848, pl. 18, fig. 7a, from Drabov Quartzite (Llandeilo), Czechoslovakia.

Drabovia sp.

Plate 98, figs. 7, 8, 12, 16, 20, 24

1986 *Fascifera* sp. Baarli and Harper, pl. 2, fig. e.

Material. PMO 109709, 111708: two moulds of brachial valves from lower 20 m of Myren Member, (earliest Rhuddanian), Solvik Formation, at Konglungø (NM 849347) and Vakås (NM 828357) in Asker.

Description. Exterior: only brachial valves known. These are subcircular, nine-tenths as wide as long, convex, and small (5–7 mm). Hinge line straight, nine-tenths of maximum width at mid-length. Evenly rounded margins. Gentle sulcus in brachial valve. Multicostellate with three or four ribs per mm at anterior margin.

Brachial valve: fairly erect brachiophores with high supporting plates. Angle between tops of plates 40°. Bases short and subparallel to convergent. Small fulcral plates present. Broad, very shallow median ridge equal in width to one muscle scar. Myophore bilobed, crenulated, and small with short shaft. Small, well-impressed, quadripartite muscle scars occupy one-third of maximum width and one-quarter to one-third of total valve length. Muscle-bounding ridges, continuous with the brachiophore bases, delimit muscle scars laterally and curve towards median ridge without meeting.

Discussion. The material is close to *Drabovia westrogoethica* Bergström, 1968, and may belong to that species.

Genus DIORTHELASMA Cooper, 1956

Type species. By original designation, *Diorthelasma parvum* Cooper, 1956, p. 998, pl. 146, figs. 5–23, from Pratt Ferry Formation (Llandeilo) of Alabama, USA. Gender neuter.

?Diorthelasma semotum sp. nov.

Plate 99, figs. 17, 22, 23, 27–29

Holotype. PMO 111670 (A) (Pl. 99, fig. 17): mould of brachial valve from the upper part of Leangen Member (early to middle Aeronian), Solvik Formation, Skytterveien (NM 820339) in Asker.

Material. PMO 103518, 105197–105199, 109759, 111670, 117417, 117418: internal moulds of eight brachial and one pedicle valves, from upper parts of Spirodden Member and throughout Leangen Member (latest Rhuddanian to middle Aeronian) of Asker District.

Diagnosis. Ventribiconvex to biconvex, minute *Diorthelasma* with relatively coarse ribbing and long hinge lines. Broadly triangular pedicle muscle scars and strong, diverging dental plates with minute teeth. Brachiophores slender and relatively long, situated on supporting plates running parallel to each other. May show well-developed crural pits and has small fulcral plates.

Description. Exterior: ventribiconvex to biconvex, minute brachiopods, 3–5 mm wide. Outline subelliptical to subquadrate, commonly half to two-thirds as long as wide. Hinge line wide, about five-sixths of maximum width which occurs one-third of length from hinge line. Commissure crenulated with broad, shallow sulcus. Cardinal angle obtuse, lateral margins evenly rounded, anterior margin gently rounded to straight. Ventral beak short, projecting slightly beyond hinge line. Notothyrium open. Ornament costellate, four to six gently rounded costellae per mm at anterior margin, separated by spaces.

Interior of pedicle valve: relatively shallow delthyrial chamber with flat floor anteriorly. Minute teeth supported by short and divergent dental plates. Muscle field broadly triangular to cordate occupying one-quarter of total valve length and situated on thickened floor. No median or muscle-bounding ridges.

Interior of brachial valve: brachiophores relatively long and slender. Together with supporting plates they form prominent, erect, triangular plates with continuations of bases varying around parallel. Small fulcral plates present. Crural pits may be well developed, especially in larger specimens. Cardinal process ridge-like on short shaft. Muscle field small and very faintly impressed, often with ribbing superimposed. Muscle-bounding ridges start at angle to brachiophore bases, and continue laterally parallel to muscle scars. No clear myophragm, but it may have very broad, thickened, triangular area between brachiophore bases. Muscle scars occupy one-third of total width.

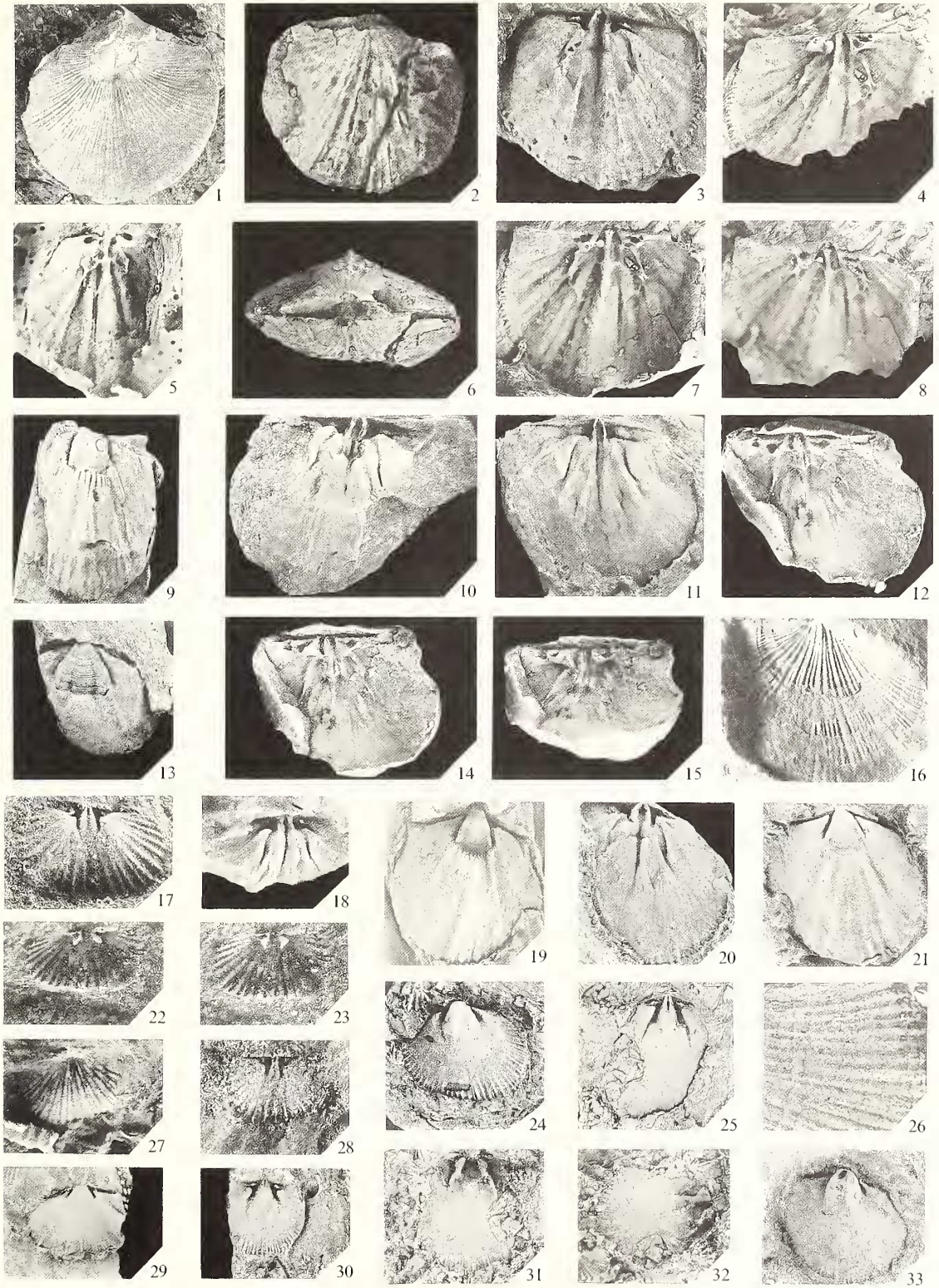
Discussion. The only earlier described species is *D. parvum* Cooper, 1956, from middle Ordovician of Alabama, USA and Girvan, Scotland. The two species are therefore separated by a long time span. Unfortunately, no Norwegian specimen shows well-impressed dorsal muscle scars that would reveal how the anterior and posterior muscle scars are situated relative to each other. Other features, however, seem to agree with *Diorthelasma*. Another possible genus is *Saukrodictya*, which is common in the uppermost Ordovician to lowermost Silurian. However, there is no trace of its peculiar honeycomb ribbing in the present material, in spite of a fairly well-preserved exterior. Also, the brachiophores in ?*D. semotum* seem to be longer and more slender, and the hinge line too long to be a *Saukrodictya*. A sure designation to genus, however, cannot be made before either the configuration of the dorsal muscle scars are revealed or the honeycomb meshwork eventually recognized.

Genus SALOPINA Boucot, 1960

Type species. By original designation, *Orthis lunata* J. de C. Sowerby in Murchison, 1839, p. 611, pl. 3, fig. 12*d*; pl. 5, fig. 15.

EXPLANATION OF PLATE 99

- Fig. 1. *Resserella matutina* sp. nov. PMO 111680, top of Leangen Member, Solvik Formation (middle of Aeronian), Jongsåskollen, Sandvika; dorsal view of whole shell, $\times 2$.
- Figs. 2–8, 18, 19, 21. *Jezercia rongi* sp. nov. From Solvik Formation, Asker. 2 and 6, PMO 111727, 15 m above base of Myren Member (earliest Rhuddanian), Spirodden; posterior and dorsal views of whole shell, $\times 2$. 3, 4, 7, 8, PMO 109732, 11 m above base of Myren Member (earliest Rhuddanian), Vakås; holotype, internal mould (3) and latex cast of brachial valve, refigured from Baarli and Harper (1986, pl. 1, fig. *m*), $\times 2$. 5, PMO 111713, 6 m above base of Myren Member (Hirnantian/Rhuddanian), Konglungø; latex of internal mould of brachial valve, refigured from Baarli and Harper (1986, pl. 1, fig. *o*), $\times 3$. 18, PMO 111707, 9 m above base of Myren Member (earliest Rhuddanian), Konglungø; internal mould of brachial valve, $\times 2$. 19, PMO 111748, 6 m above base of Myren Member, Vakås; internal mould of pedicle valve, $\times 2$. 21, PMO 111738, 9 m above base of Myren Member (Hirnantian/Rhuddanian), Konglungø; internal mould of pedicle valve, refigured from Baarli and Harper (1986, pl. 1, fig. *n*) and Baarli (1987, fig. 5*i*), $\times 2.5$.
- Figs. 9–16, 20, 26. *Chrustenopora askeriensis* sp. nov. From Solvik Formation, Asker. 9, PMO 109737, 9 m above base of Myren Member (earliest Rhuddanian), Konglungø; internal mould of pedicle valve, $\times 3$. 10–12, 14, 15, from 17 m above base of Myren Member (earliest Rhuddanian), Vakås; 10, 12, 14, 15, PMO 109734, internal mould and latex cast of brachial valve, $\times 2$; 11, PMO 109735, holotype, internal mould of brachial valve, refigured from Baarli and Harper (1986, pl. 1, fig. *i*), $\times 2$. 13, PMO 105891, basal metres of Myren Member, Ostoya; internal mould of pedicle valve. 16, PMO 111734, 11 m above base of Myren Member (earliest Rhuddanian), Konglungø; external cast of brachial valve, $\times 2.5$. 20, PMO 108281, 6 m above base of Myren Member (Hirnantian/Rhuddanian), Vakås; holotype, internal mould of brachial valve, refigured from Thomsen and Baarli (1982, pl. 1, fig. 2), $\times 3$. 26, PMO 117379, 15 m above base of Myren Member (earliest Rhuddanian), Spirodden; external mould of brachial valve showing punctae, $\times 6$.
- Figs. 17, 22, 23, 27–29. ?*Diorthelasma semotum* sp. nov. Solvik Formation, Asker. 17, 22, 23, 27, 28, top of Leangen Member (mid-Aeronian); 17, PMO 111670(A), Skytterveien, Asker, holotype, internal mould of brachial valve; 22, 23, PMO 111670(B), latex cast of brachial valve; 27, PMO 109759 (counterpart of PMO 111670), Skytterveien, Asker, exterior of brachial valve; 28, PMO 105199, Bleikerveien, internal mould of brachial valve. 29, PMO 105198, 1 m above base of Leangen Member (earliest Aeronian), Skytterveien; internal mould of pedicle valve. All $\times 6$.
- Figs. 24, 25, 30–33. *Salopina pumila* sp. nov. From base of Vik Formation (Telychian), Kampebråten, Sandvika. 24, PMO 109763, internal mould of pedicle valve, $\times 3$. 25, 31, 32, PMO 109765, internal mould and latex cast of brachial valve, $\times 3$. 30, PMO 111691, holotype, internal mould of brachial valve, $\times 4$. 33, PMO 111692, internal mould of pedicle valve, $\times 3$.



BAARLI, *Resserella*, *Jezerzia*, *Chrystenopora*, ?*Diorthelasma*, *Salopina*

Salopina pumila sp. nov.

Plate 99, figs. 24, 25, 30-33

Holotype. PMO 111691 (Pl. 99, fig. 30): mould of brachial valve from base of Vik Formation (Telychian) at Kampebråten in Sandvika (NM 848404).

Material. PMO 109763-109765, 111664, 111665, 111668, 111669, 111691, 111692, 111694, 116773, 117412-117416: internal moulds of thirteen brachial and three pedicle valves from base of Vik Formation (Telychian) in Sandvika area of Oslo Region.

Diagnosis. Planoconvex, nonsulcate, and subcircular small *Salopina* with very fine ribbing. Ventral muscle field faintly impressed and divided by shallow, median elevated area. Thin, erect, triangular, and slightly divergent brachiophores with small sockets floored by fulcral plates.

Description. Exterior: planoconvex to weakly ventribiconvex small *Salopina*. Outline subcircular. Hinge line straight, two-thirds of maximum width, which occurs posterior to mid-length. Cardinal angle obtuse and rounded, lateral and anterior margins evenly rounded. Ventral beak gently rounded, may be nearly straight, and projects slightly past hinge line. Ventral interarea apsacline, dorsal interarea anacline. No sulcus. Ornament very fine with seven costellae per mm at 5 mm growth stage. Costellae low, rounded, and equally spaced.

Interior of pedicle valve: delthyrial chamber fairly low and flat. No pedicle callist present. Teeth strong, triangular without cruralfossetts and with deep and short lateral cavities. Short, concave dental plates, which may continue in very weak, short muscle-bounding ridges. Muscle field weakly impressed, most often divided by low, broad median ridge anteriorly. The cordate muscle field occupies one-third to half of total length and two-fifths of width.

Interior of brachial valve: brachiophores thin and erect. Bases of supporting plates slightly divergent relative to tops. Brachiophores with support are thin, delicate, and sharply triangular in lateral view; they descend normal to floor anteriorly and diverge at c. 50° from one another. Cardinal process has very short, thin shaft and small, slightly bulbous myophore. Small sockets floored by fulcral plates. Muscle field weakly impressed, bounded laterally by elevated ridges that continue from brachiophore bases without sharp flexure. Muscle field quadripartite, with small posterior muscle fields and bigger anterior scars; may be longitudinally bisected by broad, low median ridge occupying one-third of width of muscle scars. Muscle scars half as long and wide as total length and width of valve.

Discussion. *S. pumila* sp. nov. is close to *S. conservatrix* (McLearn, 1924) and *S. shelvensis* Walmsley, Boucot and Harper, 1969, of equivalent age. It is distinguished from the former by the lack of a dorsal sulcus, and diverging rather than subparallel brachiophore bases; from the latter by an impressed median ridge in the pedicle valve; and from both by finer ribbing.

Family CHRUSTENOPORIDAE fam. nov.

Diagnosis. Biconvex to unequally biconvex, transverse elliptical Enteletacea. Low, apsacline ventral and anacline dorsal interarea. Fascicostellate to multicostellate. Pedicle muscle field oval to pentagonal with elongate, simple diductor scars bordering, but not enclosing or going beyond broad adductor tract anteriorly. Very short cardinalia consist of simple ridge-like to lobed cardinal process, strongly divergent brachiophores. Very short brachiophore bases extend anteriorly parallel to subparallel with continuation and do not contain adductor fields anteriorly. Fulcral plates often present, concave and flooring small dental sockets. Variably developed dorsal muscle field with oblique transverse ridges. Differs from both Dalmanellidae and Draboviidae in its very short cardinalia. The latter possesses long brachiophores, directed anteroventrally with high perpendicular supporting plates, as opposed to short brachiophores, very divergent anteroposteriorly with extremely short supporting plates. Dalmanellidae differs in having less convex dorsal valve and cordate ventral muscle field, with diductor scars usually extending beyond adductor scars. Continuation of brachiophore bases is variably disposed.

Genera assigned to Chrustenoporidae. *Dysprosorthis* Rong, 1984, late Ashgill, China, England, and ?Anti-Atlas, Morocco; *Chrustenopora* Havlíček, 1968, Upper Ordovician to early Llandovery, Bohemia, Norway; *Jezercia* Havlíček and Mergl, 1982, Ashgill to Llandovery, Bohemia, Norway, and England.

Discussion. *Chrustenopora* and the closely related *Jezercia* were placed in the subfamily Chrustenoporenae under the family Plectorthidae by Havlíček and Mergl (1982). Since the Norwegian material is endopunctate and Havlíček described *C. imbricata* as possibly punctate, I choose to move them to Enteletacea, together with the closely related *Dysprosorthis*, and to elevate the subfamily to family rank. Havlíček and Mergl (1982) used the presence of concentric perforations to erect the subfamily Chrustenoporenae. Such perforations are not found in the Norwegian material, which might be due to poor preservation—but this seems unlikely since punctae are observed.

Genus CHRUSTENOPORA Havlíček, 1968

Type species. By original designation, *Chrustenopora imbricata* Havlíček, 1968, p. 123, pl. 1, figs. 5–8, 10.

Chrustenopora askeriensis sp. nov.

Plate 99, figs. 9–16, 20, 26

1982 *Ptychopleurella* sp.; Thomsen and Baarli, pl. 1, figs. 2 and 3.

1986 *Kinnella* sp.; Baarli and Harper, pl. 1, figs. *i, j, p, q.*

Holotype. PMO 108281 (Pl. 99, fig. 20): brachial valve from 6 m above base of Myren Member (Hirnantian/Rhuddanian), Solvik Formation at Vakås in Asker (NM 828357).

Material. PMO 103494, 105891, 108281, 109734, 109735, 109738, 111714, 111734, 111747, 111749, 111750, 117379, 117380, 117388–117399: moulds of fourteen pedicle and ten brachial valves and two whole shells from Myren Member (Hirnantian/Rhuddanian), Solvik Formation, at Vakås (NM 828357), Spirodden (NM 841338), and Konglungø (NM 849347) in Asker.

Diagnosis. Ventribiconvex and transversely subcircular *Chrustenopora* with moderately fine, imbricated costellae. No fold or sulcus. Pedicle valve with thin, long dental plates and small teeth. Broad, triangular adductor area flanked by narrow, simple diductor scars. Dorsal valve has large sockets and sharp triangular dorsal median ridge with variable position of brachiophore bases about parallel. Muscle-bounding ridges in brachial valve strongly impressed, curved, and start near hinge line.

Description. Exterior: ventribiconvex and transverse, subcircular to subquadrate, from two-thirds as long as wide to nearly equal. Hinge line straight and nine-tenths of to equal maximum width, which varies between 10 and 14 mm. Cardinal angle normal to obtuse. Lateral margins straight to slightly curved for half of length, then curve evenly with anterior margin. May be faintly sulcate. Beak straight, overhanging hinge line. Ventral interarea high, dorsal interarea relatively low. Delthyrium open. Costellate to fascicostellate imbricated ribbing with three to five ribs per mm at 5 mm growth stage. Endopunctate shell.

Interior of pedicle valve: thin, convex, and long dental plates continue in strong ridges. These meet anterior margin of thickened floor of delthyrial chamber, and together delimit the semicircular to oval muscle scars. Anterior thickening sometimes crenulated. Teeth small. No pedicle callist. Muscle scars occupy one-third of length of valve. Diductor scars long and narrow. Adductor area long, triangular, and somewhat wider than one diductor scar. Adductor area may be coarsely striated. Vascula media widely divergent.

Interior of brachial valve: brachiophores with supporting plates are thick, erect, and very divergent. Sockets well developed and floored by strong fulcral plates that converge on to brachiophores. Brachiophore bases very short, and vary from nearly parallel to convergent towards median septum. Crural pits often prominent. Cardinal process thin and bilobed with shaft continuing into sharp, triangular median septum. Septum continues to anterior end of muscle scars in most specimens. Muscle-bounding ridges broad and strongly impressed, and start outside brachiophore bases near hinge line; they follow outline of long, subtriangular posterior muscle scars and diverge anterolaterally in long curved extensions. Larger anterior scars more faintly impressed, long and flabellate, and lie well inside above mentioned extensions and posterior scars. Muscle scars occupy one-third to half of total valve length. Faint transverse ridges slope obliquely anterolaterally.

Discussion. Except for the concentric perforations, all characteristics of the genus are present. The differences which justify erection of a new species include: 1, larger sockets; 2, deeper median ridge in the brachial valve; and 3, more triangular adductor area in the pedicle valve compared with *C. imbricata* Havlíček, 1968. Brachiophore bases vary from parallel to convergent, and are not divergent as in *C. imbricata*. The lateral muscle-bounding ridges in the brachial valve are curved in the new species, not straight.

Genus JEZERCIA Havlíček and Mergl, 1982

Type species. By original designation, *Jezercia ostiaria* Havlíček and Mergl, 1982, Králův Dvůr Formation, Bohemia.

Jezercia rongi sp. nov.

Plate 99, figs. 2–8, 18, 19, 21

1986 *Reuchella* sp.; Baarli and Harper, pl. 1, fig. 11 *m, n*.

1987 *Reuchella* sp.; Baarli, fig. 5i.

1987 *Ravozetina rava silvicola* (Temple, 1970); Temple, pl. 3, fig. 13.

Holotype. PMO 109732 (Pl. 99, figs. 3, 4, 7, 8): internal mould of brachial valve from 11 m above base of Myren Member (earliest Rhuddanian), Solvik Formation at Vakås in Asker (NM 828357).

Material. PMO 103495, 109732, 111707, 111713, 111715, 111727, 111738, 111748, 117401–117406: moulds of seven brachial, four pedicle, and one of exterior valves, and one whole specimen, from the lowest 20 m of the Solvik Formation at Vakås (NM 828357), Konglungø (NM 849347), and Spirodden (NM 841338).

Diagnosis. Biconvex and transverse elliptical outline with angular fold in pedicle and sulcus in dorsal valve. Coarsely subangular ribs in fascicostellate pattern. Thin, short dental plates and faintly impressed pentagonal muscle scars. Divergent vascula media. Brachiophores very short and supported by even shorter, variably directed supporting plates. Cardinal process with shaft that continues into myophore and further into median sulcus. Subcircular dorsal muscle field divided by oblique ridges.

Description. Exterior: subequally biconvex to ventribiconvex. Transverse elliptical to subquadrate outline. Maximum width 6–14 mm measured slightly in front of hinge line. Cardinal angle normal to obtuse, lateral margins straight to slightly curved in posterior half of valve, then evenly curved like anterior margin. Valve half as thick and eight-tenths as wide as long. Hinge line straight and eight-tenths of maximum width. Small angular sulcus in brachial valve varies in depth and width. Ventral interarea apsacline with low anacline interarea dorsally. Delthyrium open and widely triangular. Notothyrium open. Ribbing coarsely fascicostellate with one or two subangular ribs per mm at 5 mm growth stage and separated by deep grooves. Punctate.

Interior of pedicle valve: dental plates short, thin, and divergent at *c.* 60°; they continue into muscle-bounding ridges that delimit subcircular to subpentagonal muscle fields. No pedicle callist. Muscle scars very faintly impressed and occupying one-third of total length. Narrow diductor scars separated by very broad adductor area that continues slightly anterior to diductor scars.

Interior of brachial valve: brachiophores short, erect, and diverge at 90–100°. Very short brachiophore bases vary about parallel from clearly divergent to strongly convergent. Small sockets floored by strong, concave fulcral plates attached to hinge line. Cardinal process seems to vary from simple, thin ridge to possibly trilobed form, with shaft continuing in strong myophragm extending half valve length or continuing in sharp fold out to edge of valve. Muscle field quadripartite with elongate quadrate posterior scars slightly smaller than subtriangular anterior adductor scars. Muscle scars occupy one-third of maximum width and less than half of maximum length. Short transverse ridges run obliquely anterolaterally to each side. Muscle-bounding ridges variably impressed; they curve and bound muscle scars anteriorly.

Discussion. The new species differs from *J. ostiaria* Havlíček and Mergl, 1982, in its lack of coarse concentric perforation, its less transverse shape, and its coarser, more angular ribbing and fold. The adductor field in the pedicle valve is broader relative to the diductor scars, and the dorsal muscle scars are less elongate.

Entelatacea indet. sp. A

Text-fig. 4E-H

Material. PMO 103498, 105216: one pedicle and one brachial valve from basal part of Spirodden Member (late Rhuddanian) at Spirodden (NM 841338) and middle part of Leangen Member (early Aeronian) at Skytterveien (NM 820339) in Asker.

Discussion. These specimens may belong to different species, but they agree in size, shape, and ribbing.

Acknowledgements. I thank the staff and students of the Palaeontological Museum (University of Oslo), especially David Worsley, for their help in the field and laboratory. I am very grateful to Rong Jia-Yu (Nanjing Institute of Geology and Palaeontology, Academia Sinica) who offered constructive criticism and useful suggestions regarding the taxonomy. Financial support from the Norwegian Research Council for Science and Humanities (NAVF) is gratefully acknowledged. I thank Markes E. Johnson (Williams College) for help with the English and general encouragement. This paper is Palaeontological Contributions from the University of Oslo, no. 343.

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Typescript received 11 September 1987

Revised typescript received 18 May 1988